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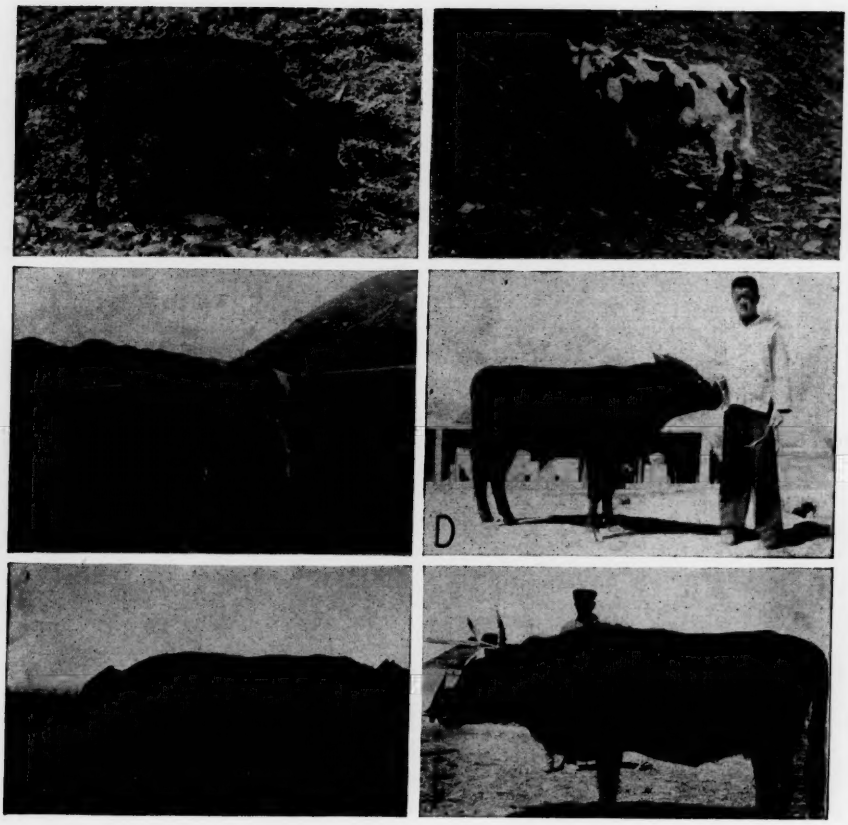

CHINESE "YELLOW CATTLE"
(SEE PAGE 163)

Identical Twins and Suicide

Dwarf Jersey Cattle

Flexed Fingers

VOLUME 37 JUNE, 1946 NUMBER 6

The American Genetic Association

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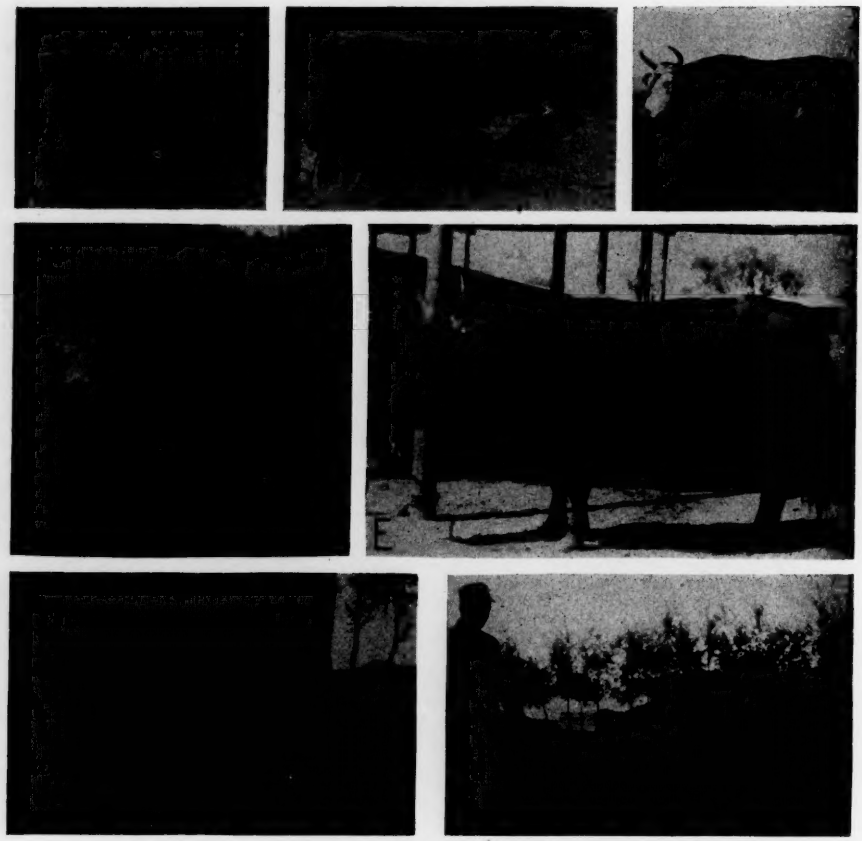


THE CHINESE NAME FOR YAK-CATTLE HYBRIDS IS "PIEN NIU"

Figure 1

In Tibet and the adjoining Chinese provinces yak-cattle hybrids are an important element in the economy. Most of them are produced by mating bulls of the "yellow" breed of Chinese cattle to yak cows. Though not as hardy as the yak, the hybrids are larger than the parent types, and produce more milk. *A* and *B*—*Pien niu* of Sikong. (Photos by T. Y. Shu, Chinese Ministry of Agriculture.) *C*—*Pien niu* of Chinghai. (Photo by F. P. Sha, Chinese Ministry of Agriculture.) *D*—*Pien niu* of Sikong. *E*—A *pien niu* of Chinghai, photographed in a commercial dairy in Lanchow, Kansu. The first five animals shown appear to be of approximately ½ yak and ½ "yellow cattle" blood. The remaining two animals are said to be backcrosses to the two parent types: *F*—¾ yak, ¼ "yellow cattle" blood; *G*—¼ yak, ¾ "yellow cattle" blood.

YAKS AND YAK-CATTLE HYBRIDS IN ASIA

RALPH W. PHILLIPS, ILIA A. TOLSTOY AND RAY G. JOHNSON*
United States Department of Agriculture, Office of Stragetic Services and Oregon State College

THE yak is indigenous to the mountainous regions of Central Asia, and wild yaks are still found in some of the more remote areas. Domesticated yaks are the most important livestock kept by the Tibetans, and they are also of considerable importance to Mongolian and other peoples farther north. These animals and hybrids between yaks and cattle are adapted to living and working at high altitudes and on rough terrain.

Travelling in the Tibetan highlands and adjacent territory recently, the authors observed closely the breeding, management and utilization of yaks. These observations are summarized here for the benefit of those who may work with this species and also for those interested in the life and livestock of Tibetans and other peoples in the highland regions of Central Asia.

During the summer of 1943 one of the authors (R.W.P.) travelled from Lanchow, Kansu in Northwest China to Sining, Chinghai, thence to various points in Chinghai Province, including Kokonor, and to points in the Kansu-Ningsia border area where yaks are maintained by Mongolian nomads. Kokonor is the Mongolian name and Chinghai the Chinese name for a large, brilliantly blue salt lake that lies in a basin at about 10,500 feet elevation.

Another author (I.A.T.) in 1942-1943 travelled across Tibet from Gangtok, Sikkim in Northern India, to Lhasa and thence to Lanchow, Kansu. The trip required about seven months and yaks and yak-cattle hybrids were used as pack animals over most of the route. This author also travelled into the Kansu-Ningsia border area mentioned above.

The third author (R.G.J.) travelled from Chengtu, Szechwan west into the eastern half of Sikong Province in the summer of 1943, travelling by caravan through the high grasslands areas of that province. Yak caravans of 14 to 300 head were regularly encountered on the Lhasa tea route, and around Lanchow, Kansu, he observed the yak-cattle hybrids.

Tibet has recently been divided into three provinces, Tibet, Chinghai and Sikong. Tibet still retains a large degree of autonomy under the rule of the Dalai lama of the Bhuddist religion, while Chinghai and Sikong are under governors appointed by the National Government of China. Although considerable numbers of Chinese have pushed into the lower valleys of the latter two provinces, adjacent to Szechwan and Kansu, the major portions of all three provinces are inhabited by Tibetans. Yaks are found throughout, and in the adjoining mountain regions of adjacent provinces. They are also found in the mountainous and high-plateau regions of Outer Mongolia and of the U.S.S.R. Observations in the latter areas, reported in the literature, are reviewed briefly, to present a comprehensive account of the way the yak serves man, and of the breeding problems encountered.

The Yaks of Tibet and Their Environment

There are no clearly distinct types of yaks in the Tibetan areas, but there are

*The authors are, respectively, (1) Senior Animal Husbandman in charge of genetics investigations in the Bureau of Animal Industry; (2) formerly Lieutenant-Colonel, A.U.S.; and (3) Head of the Animal Husbandry Department at Oregon State College. Dr. Phillips and Professor Johnson were in China under the auspices of the Division of Cultural Cooperation, United States Department of State.

wide variations in color and size, and some variation in general conformation.

The tallest animal seen measured five feet, two inches at the top of shoulder. This was an exceptionally large animal. The legs of the yak are rather short and the body is relatively deep and wide. The face is narrow, long and somewhat dished, while the forehead is relatively wide and prominent. The horns are slender, long, and generally curve outward and upward. Polled animals are also seen, although most yaks in the Tibetan plateau are horned, or have been dehorned. The back is high over the shoulders, somewhat depressed behind the shoulders, and slopes over the rump. The chest is deep in relation to height, but the rear quarters tend to be light. The legs are generally well placed and are straight and strong, although sickle-hocked animals are often seen, particularly in Sikong. Hoofs are large, somewhat cup-shaped, and quite hard. They wear even better than those of horses and mules. The shape and hardness of the hoof fit the yak for mountain climbing or for travel over marshy areas that are so common on the high plateaus. The hair of the yak is longer than that of cattle. Fringes grow quite long around the poll, at the withers and shoulders, along the sides and on the thighs. The tail is quite bushy, much like that of the horse except that the hairs are much finer and softer. Thus, the yak has a characteristic hairy appearance, and from this comes its Chinese name, *mao niu* or "hairy cattle." Domestic cattle in China are called *huang niu* or "yellow cattle" after the yellowish brown color that is often found.

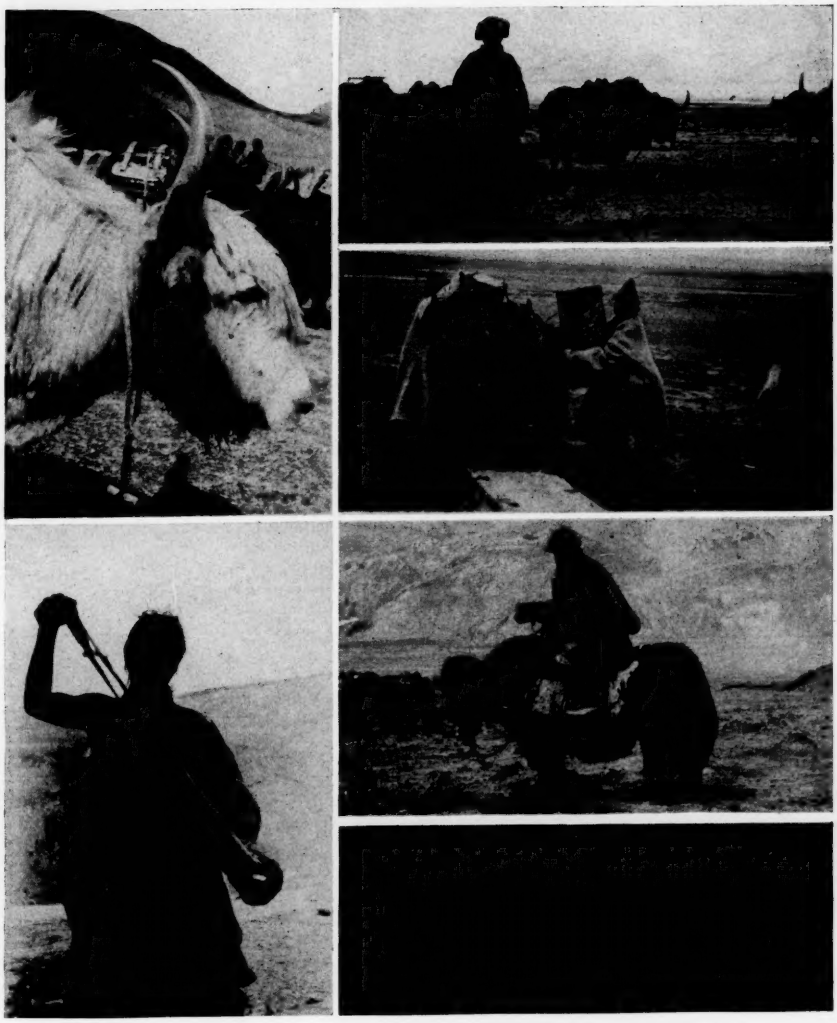
Moving south to north across the Tibetan area, a change is observed in the size and character of the yak. They are first observed on the Himalayan foothills, a few miles north of Gangtok, Sikkim. These animals are rather small, with somewhat longer bodies and generally inferior conformation to those farther north. They were in good condition when observed in October, and the southern slopes of the Himalayas usually offer abundant feed.

North of the Himalayas the first plateau stretches almost from the mountains to Lhasa. The elevation is about 14,000 feet, with some valleys as low s 12,000, and a number of lesser mountain ranges stretch across the plateau. The region is rather arid, and lower portions are badly overgrazed by cattle, sheep and goats. The yaks graze primarily on the slopes, and are seen up to 17,000 feet where the grass is more abundant. These yaks are also small, but stocky and generally of better conformation than those south of the Himalayas. Black is the predominant color.

North of Lhasa, up to the Tsangnela Mountains, which divide Tibet and Chinghai Provinces, the country is very mountainous and rugged and there is little cultivation in the valleys. The yaks in this area are noticeably larger than those farther south. Beyond Jyekundo many variations in color are observed, including black, black and white, and reddish-brown and white. The brown may vary from a rather deep reddish-brown to a light cream. One albino yak was seen in this area.

In Chinghai Province, north of the Tsangnela Mountains, the country is mountainous and there is little cultivation in the valleys. There are extensive grazing areas and pastures are less grazed down. The largest yaks are found in this area and there are some excellent herds. The predominat color is black, but some other colors are seen, including various shades of brown, and white-and-black, or white-and-brown.

The yaks in eastern Sikong are similar in conformation and color to those of Chinghai, but are probably somewhat smaller. Female yaks in Sikong are estimated to average 109 cm. in height and 225 kg. in weight. Males are larger on the average and some become quite massive. This province is mountainous and rugged, but being farther south has a less rigorous climate than Chinghai and there is more cultivation in the valleys. There are extensive grassland areas for grazing.



METHODS OF HANDLING YAKS AND *PIEN NIU*

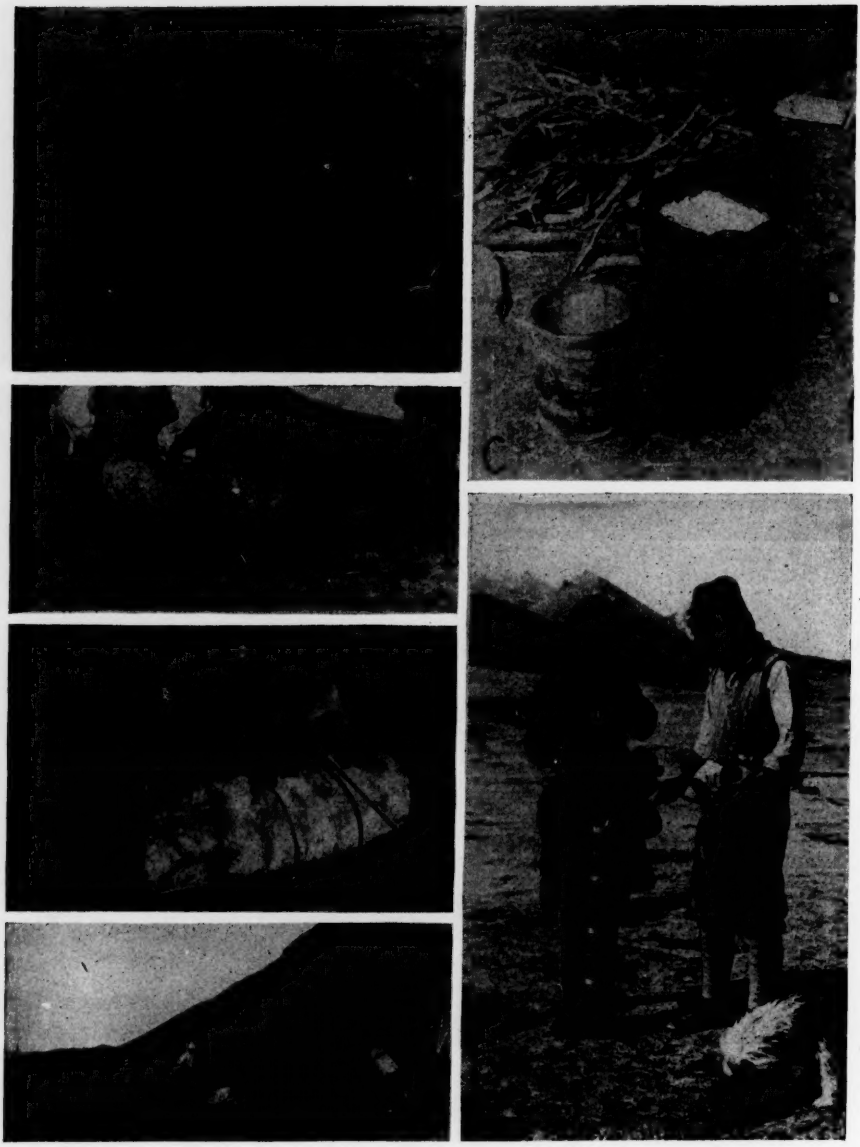
Figure 2

A—Head of a yak, showing the neck rope that is used for tethering at night. *B*—Pack animals tethered for the night. *C*—Loading a pack animal. Note the wooden nose rings, which are used in some areas instead of a neck rope. *D*—A Tibetan demonstrates a sling shot, used to keep the animals in line in caravans. *E*—A yak being used for riding. *F*—A yak being used as a draft animal. Note the pack saddle adapted to serve as harness.

Some of the varied colors seen in the yak may have been introduced through crossing with cattle. The hybridization practices are discussed in a later section, but it should be noted here that many animals which have the conformation and general appearance of the yak probably carry genes from cattle introduced several generations earlier.

Methods of Handling

The domestic yak is a shy, careful animal, and although it is easily alerted, it is seldom agitated. Bulls may be



YAKS AND *PIEN NIU* PRODUCE FOOD, CLOTH AND LEATHER

Figure 3

A—A Mongolian woman milking a *pien niu*. Note the brindled color and the yak-like tail. (Photo by E. A. Tunnicliff, Montana State College.) *B*—Butter is being churned in a yak-skin churn, which is rolled about to do the churning. Wooden-barrel churns are also used. *C*—Skim milk is boiled to coagulate the casein, which is seen draining here. It is then dried in the sun and stored for winter use. (Photos in *B* and *C* by T. Y. Hsu, Chinese Ministry of Agriculture.) *D*—A coracle or boat made from yak skins. *E*—A yak-hair tent. *F*—Tea and rancid butter are combined for mixing in a narrow barrel churn, to make the Tibetan's favorite drink, buttered tea.

dangerous during the mating season, and a nursing cow may charge a horse and rider if they approach her calf too closely. When surprised or frightened, yaks may stampede for a short distance, but soon stop and quiet down. Pack animals that have not been worked for a time are apt to be difficult to handle for the first few mornings when put back to work, and often buck off loads. However, with quiet handling they soon settle down.

Natives of Central Tibet are among the best handlers of yaks. Their animals seldom have rings in their noses, but have a neck rope, one end of which goes through a loop, with a wooden pin which serves as a stop. It operates as a choke collar, and when picketed, animals are tied to this rope collar. When driving pack herds, much use is made of the voice, but a sling-shot is often used to hurl small stones at animals that get out of line. At night animals in pack trains are usually picketed to a line laid out as a square pegged to the ground at each corner, and they usually take their places readily in the picket line. A yak seldom kicks, uses his horns, or tries to run and drag a person. In eastern portions of the Tibetan area, nomads and some Chinese settlers often treat their animals roughly, which of course makes for more difficult handling, and most of the animals have wooden rings in their noses.

Yaks are extremely quick in their movements and their first dash or swerve is as fast, possibly faster, than that of horses. The walking speed, depending on load and terrain, is from a mile and a half to two miles per hour. If not driven, they will always slow down to feed along the way. They can be driven fast on short trips, if in good condition, but this requires more work for the natives who by nature are never in a hurry. Yaks are remarkably adept at picking their way over difficult terrain, and in this respect are superior to mules. Yaks are also adept at plowing through snow. One of the authors (I.A.T.) and his party probably owe their lives to this ability of the yak! The party was in a pass at almost 17,000 feet elevation, and snow was four feet deep. The loaded yaks soon got winded and tired. The lead yak stopped: the second animal came up and made a few lunges further forward. The third yak then carried on until tired. This performance was repeated with perfect team work until the end of the deep snow was reached. In swampy areas the yak does not get excited and start to lunge as most horses and mules do when sinking. When stuck, the yak turns and tries another way, or may back out and start anew. When sinking, it walks in a long, slow stride, dragging its wide body along the swamp like a boat.

The yak is adapted to high altitudes and does not appear to be adversely affected by cold weather and snow. It does not stand up well in hot weather and is seldom found at low altitudes. It is very adept at ranging for feed on the mountains, and as a rule, when turned loose will go to the higher elevations to feed, at times above 17,000 feet to places where cattle and horses would have difficulty finding a footing. The yak is also very adept at digging through snow for feed. When grass is extremely scarce, and cattle and horses cannot long survive, the yaks eke out an existance by licking up broken and wilted blades of last year's grass which have been blown by the wind and partially imbedded in the soil. In such areas yak may spend eight hours a day licking up dead grass, and thus stay alive and keep on working. This is the reason pack trains often do not move more than eight or ten miles a day.

These animals are packed with anything that has to be moved. Caravans travel in all directions and only deep snowdrifts in the passes and valleys stop them from moving. Long trips are usually made in the summer, when the snow is not difficult and grass is most abundant. Even with relatively poor feed, the yak can carry his load eight to ten miles a day and stay in good condition, for months at a time. Travel usually is scheduled to start about 4:00 or 5:00 A.M., and to stop soon after

noon. The animals then graze until dark, when they are picketed for the night. Picketing serves as a precaution against bandits and makes the animals available for early morning packing. One of the authors (I.A.T.) moved at a rate of 15 to 32 miles per day for a period of two weeks, with a pack train of around 100 exceptionally good yaks in relatively good condition, with loads of 120 to 160 pounds. To cover these distances the nomads freed their animals for early dawn grazing, and a few spare animals were carried to relieve tired ones.

The primitive pack saddles consist of small wooden frames set on a few layers of felt, with hair rope for girth, breast plate and crupper or breeching. When an animal is working, the saddle may be kept on for weeks at a time. Even so, there are relatively few sore backs.

In the higher areas no supplementary feed is available, and in the valleys where crops can be raised, most of the straw is fed to horses, cattle, sheep and goats. Some cut feed is given to yak-cattle hybrids in lower valleys, particularly to those animals that are giving some milk during the winter months, and to limited numbers of animals that are kept in towns most of the year for dairy purposes.

The most damaging diseases are rinderpest, pneumonia and foot-and-mouth disease, epidemics frequently resulting in heavy losses. Veterinary practice does not exist in most of the highland region, except for religious and superstitious practices of lamas or monks.

Herds of yak cows are usually taken up to high elevations for grazing during the summer and the Tibetan families live there in tents, collecting butter and dried casein for winter use. In the winter they move back to lower elevations. No forage is cut and dried for winter use other than grain straw, and yaks seldom, if ever, eat this. Choice animals may be kept alive on dried casein during periods of extreme winter weather. In many regions the ranges are over-stocked and there is urgent need for introduction of improved range-management practices.

Uses and Products of the Yak

The value of the yak as a pack animal has been emphasized. Many Tibetan families depend largely on it and yak-cattle hybrids for many of the necessities of life.

Hides are used for soles of boots, for rope, for all purposes where leather is required. One wasteful practice observed is the wrapping of tea bricks, butter, salt, and other items in raw, wet skins for transport. The skins usually deteriorate in transit and are of no further use. The long hair is used for rope and for weaving into heavy, strong cloth from which tents are made.

Meat is eaten fresh or dried for winter use.

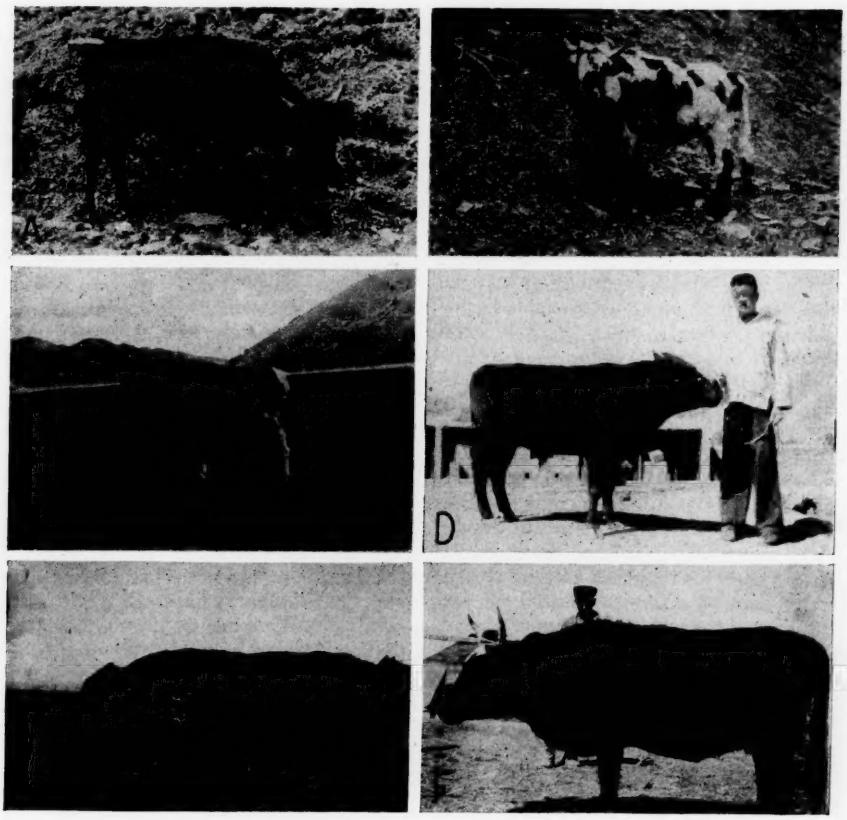
Milk is used fresh and also made up into butter, dried casein, and a variety of hard cheeses. These products are stored in considerable quantities for winter use. Dried meat and cheese are also fed to horses to keep them alive during severe winter weather.

Dried manure chips constitute the only fuel in the high altitudes where there are no shrubs to burn.

Few data are available on the milk production of yaks in the Tibetan area. Records being collected at the Pa Mei Livestock Farm in Sikong indicate that under native conditions of feeding and managment the yak produces 2.5 to four pounds of milk daily for a period of four to five months. Some of the better ones may give a little more and for a longer period. The milk is generally of a rich golden color and the butter is quite yellow. In central Tibet, where observations were made during the winter months, both the milk and butter were quite white. This may have been due to the lack of green feed during this period.

Yak-Cattle Hybrids

These hybrids are called *dzo* by the Tibetans and *pien niu* by the Chinese. Most of them are the result of mating



"YELLOW CATTLE" OF THE TYPE USED FOR CROSSING

Figure 4

A—A two-year-old bull in Sikong. *B*—The best bull seen (by R. G. J.) in 33 days of travel in Sikong. *C*—Another Sikong bull. (Photo by T. Y. Hsu, Chinese Ministry of Agriculture.) *D*—A bull in Lanchow, Kansu, that was somewhat over one year old. *E* and *F*—Bull and cow of Chinghai Province. (Photo by S. F. Wu, Northwestern Agricultural College, China.)

"yellow" bulls to yak cows,* but some are also the result of the reciprocal cross. The Chinese term has been used in an earlier publication[18], in which these animals are briefly described, hence it will be used here for the sake of uniformity.

The *pien niu* is intermediate to yaks and cattle in conformation and general appearance, but there is evidence of heterosis in the greater size, strength and reputed increased milk production. Lus[16] found that hybrids in Mongolia were larger in all their measurements than either of the parent types and weighed 18 percent more than cattle. In Sikong workers estimated that the hybrids are about one-fifth larger than the yaks. It is generally conceded that the *pien niu,* while larger and stronger,

*For simplicity we have used the term "yak-cattle" to designate both types of crosses, even though in some cases this violates the general rule of naming the male parent of a cross first.

does not have the staying power of the yak. It has softer hoofs, is apt to become lame on long treks, cannot negotiate difficult terrain as well. It suffers more from cold and is not so adept at gleaning a living from scant pastures. Some of its advantages, other than greater size and milk production, are its greater ease of handling, and its ability to withstand a warmer climate so that it can be used at lower altitudes.

The size and conformation of the *pien niu* are of course as variable as the size and conformation of the cattle and yak used to produce them.

The cattle on the southern slopes of the Himalayas and immediately north of them are rather small and inferior. They are narrow, long bodied, and similar to the hill cattle of northern India. The hump is small or entirely lacking. Similar small cattle are found in Sikong Province. The *pien niu* produced by crossing yaks with these cattle are generally lacking in size, muscling and straightness of leg, when compared with those found farther north, although they are larger and stronger than the native cattle and yaks. The hybrids from these crosses of yaks with small cattle are not, therefore, as useful for transport as those from larger cattle.

In the region north of the Himalayas, up to the Tsangnela Range, the cattle are small but compact and they have greater depth and width of body than those farther south. Their legs are straighter, hoofs harder, and their horns are short and stubby. Many brindle-colored animals are seen, and they are probably closely related to the Mongolian cattle found farther north. The *pien niu* produced by crossing these animals with yaks are very fine animals.

From the Tsangnela Range to Kokonor, about halfway to Sining, Chinghai, very few cattle and few hybrids are produced. But between Kokonor and the area around Sining, many hybrids are produced. The cattle are of Mongolian type, somewhat larger than those found further south. Most of them have reasonably straight legs and good feet. There is considerable variation in conformation, some being quite well muscled, while others are lean and more of a dairy type. The hybrids in this area are of outstanding quality. The best herds are maintained by the Governor of Chinghai Province, who uses them for military transport. These animals are deep, broad-backed, with straight legs and strong feet, and stand up to five feet at the shoulder. Colors include many black animals with white markings, blue roans, brindle animals and others with shades of brown varying from dark to light cream. A nearly white animal is also seen occasionally.

An example of the performance of the hybrids in Chinghai will serve to illustrate their usefulness. A detachment of cavalry was moved from near Sining to Jyekundo, approximately 450 miles, over snow-covered terrain. A caravan of *pien niu* served as pack animals for the detachment, carrying grain for the horses and mules, and other supplies. This caravan stayed with the cavalry, and completed the march in 27 days. All the animals were in good condition at the start, but when observed shortly after the end of the trip, the *pien niu* were in better condition than the horses and mules. This appeared quite remarkable since the pace was rapid and the *pien niu* had to dig for the previous year's grass under the snow while the horses and mules were fed grain.

Few data are available on the milk production of hybrids. It is generally believed to be somewhat higher than that of yaks. In a herd of about 100 hybrids maintained in a commercial dairy in Lanchow, Kansu, it was stated by the manager[9] that the average daily production for the lactating animals was five pounds and that they were milked for about seven months. One exceptional animal gave as much as 20 pounds daily. Most of the animals in this herd were purchased in Chinghai. Tests[15] on the fat content of milk from four hybrids in Sikong showed an average of 5.6 percent. These animals had freshened in the spring and the data on fat percentage were obtained on July 1.

(*The second half of this paper will appear next month.*)

TWIN STUDIES ON THE PSYCHOPATHOLOGY OF SUICIDE*

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SUCCESSFUL execution of suicide has long been recognized as a highly complex phenomenon with implications in many fields of socio-biological interest. From a general psychopathological standpoint, the act of taking one's own life or the failure to save it when death threatens may be regarded as the final result of a compulsive-regressive behavior pattern, which somewhere begins with an apparently unadjustable conflict in a person's life history and abruptly ends with the admission of complete defeat.

The motives, methods, and cultural background factors of this self-destructive pattern vary as much as do the procedures of its forensic verification and statistical recording. Other difficulties arise in an attempt to appraise the interaction of individual personality deviations and distressing life conditions which set the stage for an epic conflict between the urge to self-preservation and that to self-destruction. However, the biological effect of a suicidal act is so clearly defined that the finality of its behavioral pattern has become one of the focal points of psychological and sociological orientation. Unfortunately, there has often been an inclination to over-emphasize individual motivational factors in a usually complicated scheme of causation. The least assertive expectation has been that "there must be a common denominator or set of factors which makes for a particular unfitness for satisfying the demands which life imposes upon one and all irrespective of social environment and external conditions."[8]

The *social* significance of suicide is obvious if one considers that intentional self-destruction stands eleventh as a cause of death in our culture[1] and is one of the most palpable expressions of its deficiencies. The suicide rate in cities considerably exceeds that of rural districts, and more persons die of suicide than of appendicitis. Three times as many men as women take their own lives.[4] Even under comparable socio-economic conditions suicide is more common in whites than in negroes. Evidently, social and cultural factors produce important modifications of the general suicide rate, so that it is often referred to as an adequate index of the economic distress and emotional frustration that prevail in a certain group.[3]

Psychiatric Classification

The *psychiatric* classification of suicide is still controversial, even if one disregards involuntary acts of self-destruction enforced by religious custom or political compulsion. Indian suttee and Japanese hara-kiri are ceremonial forms of capital punishment and no more determined by a personal choice between life and death than was the fate of a political prisoner in a German concentration camp. The methods and cultural settings of self-destructive acts by "custom" may differ considerably, but psychopathologically it would seem inadvisable to distinguish such acts from forced execution.[9]

The mental disorders most frequently associated with *intentional* suicide are depressive and delusional syndromes, hypochondriacal states with self-depreciative ideas of guilt and dejection, and severe psychoneurotic reactions to loss of a love object and consequent ambivalence toward it. In psychological terms,

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suicidal acts have been described as introjective aggressions which lead to a regressive break with reality in order to annihilate some hated object. The inference is that no one commits suicide who does not want another person to die. According to Lewis, "we are born for love and hate and always in trouble but most of us escape a major reason for man's grand total retreat from the vicissitudes of life."

Many psychiatrists believe that every suicide is classifiable as pathologic or even as falling within the dimensions of a psychosis, while others consider this concept extreme. Kraepelin and Salmon estimated that over one-third of all suicidal cases had a known history of mental disease. About 70 per cent of these definitely psychotic cases were classified by them as manic-depressive. Concerning suicides without certified history of mental disorder, it has often been stressed that the possibility of obscure psychotic processes is to be considered. Many unexpected and apparently "philosophical" suicides are misinterpreted as the result of overwork, sex problems, alcoholic conversions or physical disabilities rather than as a symptom of a disguised endogenous depression.[8] According to psychoanalytical theory, only the mentally deranged lack those strong attachments which keep normal persons alive by preventing them from self-destruction.

Hereditary Factors in Suicide

Similar uncertainties exist in regard to the relative effect of *heredity* in the production of significant variations in the suicide rate. There have been reports on the accumulation of suicide in certain families, and only recently our attention was called to a syndicated story about a Spanish family, in which a direct male descendant committed suicide at the age of forty-five in five consecutive generations. In one of our own family studies,[5] the suicide rate of various groups of blood relatives of schizophrenic index cases was found to exceed consistently that of a comparable general population (Table I). The increase was more pronounced for the children and siblings of schizophrenic patients than it was for their nephews and nieces.

For obvious reasons one cannot expect that there would be a specific combination of genetic factors determining the occurrence of suicide as such. There is no inheritance of any finished human traits, but only a transmission of potential capacities for the development of these traits under certain life conditions. It is conceivable, however, that genetic elements may play a significant part either in the formation of some personality types with particular vulnerability to suicide under stress, or in the development of special forms of mental disease which favor the tendency to self-destruction. Since suicide can be considered as an expression of the inability to survive under competitive circumstances, there is a definite possibility that certain biological deficiencies in the individual capacity for adaptation to competition in life may in part depend upon heredity. The inseparability of inherited and acquired components in the "preservation of organic unity" has been emphasized in relation to suicide by Lewis and others.[8,9] It may be admitted, however, that our knowledge of the biophysiological phenomena of adaptive integration on varying organic levels is still very incomplete.

The complexity of the human equation of suicide ostensibly calls for an attempt to investigate the relative importance of emotional, social, and biological factors in self-destructive acts with the only "experimental" method directly applicable in man, *the twin study method.*

By comparing one-egg and two-egg

TABLE I. Suicide Rate of Blood Relatives of Schizophrenic Index Cases

Suicide Rate in Relation to	General Population	Consanguinity to Schizophrenic Index Cases			
		Children	Grand children	Siblings	Nephews and Nieces
All Persons Born	0.4	1.3	0.3	1.8	0.8
All Deceased Persons Aged 10-59	2.4	11.6	8.3	8.0	6.6

twins, twins of the same and of opposite sex, twins reared together and apart, and twins with and without a certain type of psychosis or with and without some particularly distressing experience, we obtain a fairly controlled situation for an analysis of interacting variations in individual personality and constitution, the extent of competition in life, special manifestations of psychopathology, and the cultural background of a suicide.

If hereditary factors play a decisive role, we should find a concordant tendency to suicide more frequently in one-egg than in two-egg pairs, regardless of ordinary differences in environment. If the main emphasis is to be placed on certain constellations of non-genetic factors, concordance as to suicide should be expected in some twin pairs of either type, who shared the same environment and responded to a similar degree of distress with the same type of psychosis.

Six Historical Cases

In reviewing the psychiatric and forensic literature, we have not been able to find more than six references to twin suicide cases. Only two of them, the cases of Soukhanoff[14] and Philip Smith,[13] were reported during the last fifty years and appear absolutely authentic. Either suicide occurred in one member of female twin pairs whose two partners had had very similar histories of an apparently manic-depressive psychosis.

The other four suicides were recorded by Baume (1863) and Stephen W. Williams (1812) and probably occurred in pairs. Baume's case as quoted by Lange[7] was that of two twin brothers who entered into a suicide pact following a depression in one of them and soon after the discovery of a theft committed by both. Williams' case as reported by Rush, Lange[7] and Loewenberg[10] appears to be the only one on record, in which two probably identical twin brothers took their lives under similar circumstances and in precisely the same manner, but at different times and places; namely, about two years and 200 miles apart. These suicides apparently occurred soon after the American War of Independence and were committed by two army captains who were both happily married, independently wealthy and highly respected in their respective New England communities. They cut their throats with their own razors during the recurrence of what was called a "partial melancholy derangement." It was also reported that their mother and two sisters were psychotic, but it is obvious that the practical usefulness of this entire case is more historiographic than psychiatric.

Eleven Current Cases

During the past ten years we have been collecting twin index cases, from the mental institutions, tuberculosis hospitals, old age homes and certain other sections of the State of New York population. This file now comprises about 2,500 twin pairs. A review of these cases supplied a total of only eleven twin pairs with suicide of one member and survival of the other twin beyond the crucial age period. Our search for twin pairs with suicide of both partners has been no more successful than that of Loewenberg, Von Verschuer and other investigators.

The sex and zygocity distribution of our *discordant* twin suicide cases is shown in Table II. All of these eleven individuals were members of the white race; four were male and seven female; three were monozygotic and eight dizygotic; and five had no history of psychotic manifestations, while the other six were psychotic twin index cases who had been admitted to a mental hospital before they committed suicide. No one of these suicides occurred during hospitalization in a mental institution.

The psychiatric classifications of the psychotic suicide patients included three cases of manic-depressive psychosis, two cases of involutional melancholia, and one case of schizophrenia. Of the co-twins of apparently non-psychotic twin suicide cases, two were hypertensive and one each was manic-depressive, schizophrenic, and epileptic (with chronic alcoholism and general paresis). The suicidal methods used consisted of poisoning

(4), drowning (2), gas (2), hanging (2) and jumping from a high place (1).

The essential data concerning the histories of the eight *dizygotic* twin suicide cases are summarized in Table III. The ages at which their suicides occurred, ranged from 28 to 61 years. The life span, available to the surviving twins from the time when the cotwins took their lives, amounted to an average of seventeen years. The family histories showed a considerable number of psychoses in the close consanguinity, with a predominance of endogenous depressions and a total of seven additional suicides in consanguineous members of three index families.

The childhood history of the respective twin index partners was the same for all pairs, disclosing definitely unfavorable home conditions in two instances. Three pairs continued to live under very similar circumstances throughout their adult lives. In two cases, personal accomplishments, marital adjustment and socio-economic status were more favorable for the surviving twins, but in three cases they were clearly in favor of the suicidal twin partners. Actually in two of the latter cases it was rather difficult to understand why it was not the other twin who found life unbearable.

In general, the differences in the personal, social and psychiatric histories of these eight twin pairs were within such limits as may be found in any pair of siblings. There is no evidence in any of these eight cases that the suicidal twin had a clearer motive or a better opportunity to commit suicide than the survivor.

A direct comparison of the developmental aspects of one-egg twins is so much easier that it seems advisable to render a more detailed account of the life histories of our three *monozygotic* twin pairs. The suicide in the first case is clearly the result of "force majeure" and practically falls into the category of involuntary self-destruction.

TABLE II. Sex Distribution and Psychiatric History of All Recorded Twin Suicide Cases

		With History of Psychosis		Without History of Psychosis		All Twin Suicide Cases
		Male	Female	Male	Female	
Previous Investigators:	Monozygotic	2	1	2		5*
	Dizygotic		1			1
Present Study:	Monozygotic	1	1		1	3
	Dizygotic	1	3	2	2	8
All Recorded Twin Suicide Cases		4	6	4	3	17

*Including four members of two possibly concordant pairs.

Anna and Emma

The twin sisters, Anna and Emma, lived together in the comfortable home of their Jewish parents in Belgium until they were married at about the age of twenty-three. They were described as very attractive and of superior intelligence and were very much alike in appearance and personality. The family was wealthy and highly respected, but included a maternal aunt who had several depressions. The twins attended the same schools and remained practically inseparable even after their marriages, although Emma was always a little more active and aggressive. She married first and also held a slight advantage in the choice of her husband. Anna's marriage originally seemed to be one of convenience, but later turned out to be equally stable and well adjusted. Both had two children and enjoyed excellent health.

Following the German invasion in 1940, Anna with her own family succeeded in escaping to the United States. Emma's family planned to follow a few weeks later, but failed to obtain the permission of the German authorities. The same was true for her parents who both committed suicide in November, 1942, when they received the order to report for transfer to a concentration camp in Poland. Four months later, upon receipt of a similar order, Emma and her husband took their lives in the same manner, by gas, together with three other couples living in the same apartment house.

Anna was 48 years old when she came to the United States in 1940, and made a satisfactory adjustment here. She

showed no evidence of any physical or mental disorder as attested by a close relative who is a competent physician. In November 1943, when she received a Red Cross letter notifying her of the suicides of her twin sister and the other family members, Anna went to see friends in the same building in order to bring them the news. Upon return to her own apartment, she suddenly collapsed with the symptoms of a massive cerebral hemorrhage which caused her death within a few hours.

Evidently, the almost simultaneous death of these twin sisters by self-destruction and shock, respectively, was due to extraneous circumstances beyond their own control. It is needless to speculate whether Anna might still be alive without the enforced suicide of her twin sister.

Howard and Elmer

The life histories of the second pair, Howard and Elmer, matched with similar consistency up to the age of 61 when Howard committed suicide. The twin brothers looked and behaved so much alike that they were mistaken for each other even by their own wives and parents. They came from an old New England family with several cases of tuberculosis on the paternal side. The father himself, a distinguished minister, died of tuberculosis in his thirties. The only sister was a supervisor in an African leper colony and, following her marriage to a missionary, did active work with him in China.

The twins had the same friends, interests and musical talents, attended the same schools, and were capable of the same amount of work. Both became school teachers and ended as high school principals in the same county. They married around the age of 25 and took their brides from similar middle-class families. Although they had practically the same responsibilities and earning capacities, Elmer was always a little better off. His wife was more economical and they had only two children, while Howard had three to bring up. Neither marriage was really happy, because both wives felt that the twins remained closer to each other than they ever were to them. However, Elmer's wife seemed more unselfish and adjustable; at least, she was easier to get along with and accepted her new relations more readily, while Howard's wife was very jealous and rather unpopular.

The twins had always been susceptible to colds and, at the age of 52, both developed mild tuberculous lesions in association with symptoms of what was called a nervous breakdown. They were restless, apprehensive and self-absorbed, became more and more dissatisfied with their teaching and home conditions, and complained of forgetfulness and irritability. Following treatment in a private institution, they recovered sufficiently within a few months to take up their old activities. However, Howard was apparently unable from then on to regain his economic balance and to reestablish a satisfactory relationship with his discontented and quarrelsome wife. Although he took on as much extra work as he could find, he often depended on the financial assistance of his equally worried but moderately more prosperous twin brother, and eight years later, at the age of 60, he had another breakdown.

Upon readmission to a mental hospital, he again showed symptoms of restlessness, volubility and dejection. He was worried about his financial status, but tended to change quickly in his mood and often made jocular or sarcastic remarks about his emotional instability. Although his mental state was thought to resemble a manic-depressive psychosis, it finally was diagnosed as psychosis with arteriosclerosis. After six months, his condition was considered so much improved that he was placed on convalescent status. A short time later he drowned himself in a lake near his twin brother's home.

Elmer was so prostrated by Howard's suicide that he gave up his position and moved to another community. He is now 70 years old and still rather depressed, but he seems fairly resigned to the loss of his twin brother.

TABLE III. Histories of Dizygotic Twin Suicide Cases

General Background Factors			Suicidal Twins					Surviving Co-twins				
Family History	Family Milieu	Age of Twins at Separation	Sex	Personal History	Psychiatric History	Age at Suicide	Method of Suicide	Sex	Present Age	Personal History	Psychiatric History	Socio-economic Status
Many relatives with depressive and alcoholic states, drug addiction and emotional instability.	Rigid and inadequate with economic distress when father (minister) deserted the family.	18	Male	Postal clerk, happily-married, no children	Moderate emotional instability without psychotic symptoms or hospitalization	35	Drowning	Male	47	Electrician, divorced, no children	Several severe depressions with hospitalization	Dilapidated, always inferior
Incomplete, except for paternal grandmother's hospitalization (involutional melancholia).	Satsfactory	....	Male	Haberdasher, married, no children	Mild depressive psychosis with hospitalization	28	Poisoning	Male	39	Waiter, married, no children	Minor depressive states without hospitalization	Equally satisfactory
Several relatives with depressive states and chronic alcoholism.	Very satisfactory	17	Male	Farmer, happily married, one child	Two depressions and one manic attack with hospitalization	53	Hanging	Male	66	Farmer, happily married, 4 children	Stable personality without psychotic symptoms	Equally satisfactory
Many depressions and other mental disorders in mother's family including 3 suicides.	Inadequate	16	Female	Housewife, married, no children	Moderate emotional instability without psychotic symptoms or hospitalization	34	Hanging	Male	81	Engineer, married, no children	Fairly stable personality with senile psychosis and hospitalization at age 72	Equally satisfactory
Several depressions and 2 schizophrenia-like psychoses in the collateral lines of ancestry.	Satisfactory	23	Female	Housewife, married, no children	Several attacks of depressive-paranoid psychosis with first hospitalization at age 43	61	Poisoning	Male	68	Supervisor, married, 2 children	Fairly stable personality without psychotic symptoms	Always more satisfactory
One uncle committed suicide, other family history unknown.	Satisfactory	18	Female	Housewife, happily married, one child	Fairly stable personality without psychotic symptoms or hospitalization	34	Poisoning	Female	Died at 65	Housekeeper, divorced, no children	Emotional instability with epilepsy, chronic alcoholism, promiscuity and general paresis	Very dilapidated, always inferior
Many depressions and 3 suicides in 2 generations.	Strict but otherwise satisfactory	19	Female	Artist, divorced, no children	Several depressions and hospital admissions	39	Gas	Female	52	Housewife, married, one child	Marked emotional instability without psychotic symptoms or hospitalization	Slightly more favorable
Several psychoses on both sides of the parents.	Strict, very religious and moderately inadequate	18	Female	Research technician, unmarried, one unhappy love affair	Stable and very popular personality without psychotic symptoms or hospitalization	39	Poisoning	Female	42	Nurse, unmarried, several unhappy love affairs	Emotional instability with schizophrenic psychosis and hospitalization at age 40	Less adequate and successful

Even this pair of identical twins with extremely similar psychiatric, marital and social histories did not fail to disclose minor variations in the environmental circumstances which preceded the suicide of one twin. The variations consisted of certain dissimilarities in marital disharmony, economic frustration and emotional instability, but they were limited differences in the degree rather than the type or constellation of distressing life conditions as they prevailed for both twins.

Another difference of possible significance was that following Howard's suicide, Elmer had no person who could serve as a suitable object for further competition and projection. From a purely psychological standpoint, this difference might be considered as a plausible explanation of Howard's discordance as to suicide. However, the emphasis of this explanation would be on the factor of intensified sibling rivalry in twin pairs as the principal cause of one twin partner's self-destruction. In order to uphold such an interpretation it would be necessary to demonstrate that lack of a sibling provides protection against the tendency to suicide. Otherwise, neither the persistence of sibling rivalry nor the possession of a really hated relative can be regarded as sufficient to explain the act of homicide or suicide.

In any case, it should be borne in mind that the similarities in the life histories of these twin brothers outweighed by far the dissimilarities. Actually, Howard's suicide created a more serious hardship for Elmer than either of them had ever been subjected to before. The similarities in their histories included religious background, professional standing, general economic status, marital maladjustment, arrested tuberculosis, and a hypersensitive type of personality with irregular mood swings and at least one major depression which required hospitalization. However, the combination of all of these factors in the same genetic and environmental settings did *not* add up to the same end result of suicide.

Nelly and Mary

The cultural and psychiatric background conditions of the third pair were significantly different. Nelly and Mary were born into a poor and uneducated family which consisted of a timid and shiftless father, a shrill, rigid and irascible mother, and four older sisters who all left this stormy, unhappy home as soon as they grew old enough. The mother quarreled incessantly with her children, never gave them any spending money and brought them before Adolescent Court at the slightest provocation.

The twins were born without any evidence of birth injuries, developed equally well, and especially as children looked so much alike that they were frequently mistaken for each other. When they entered school it was discovered that Nelly had a heart lesion which was diagnosed as a congenital defect due to a patent ductus arteriosus rather than as rheumatic in origin. She was placed in a special cardiac class and treated as a cardiac invalid for the entire time of her schooling. She was not allowed to run around with the other children or take part in games, excursions or athletic activities. At the age of 17, she was told that she had "outgrown" her lesion and could now consider herself as a normal girl. Later examinations (Dr. M. Harris) showed only a moderate enlargement of the pulmonary conus, but no murmurs or any evidence of an impaired cardiac reserve. There never were any pathological findings in Mary's cardiac investigations.

Apart from a reversal in handedness and the differences in schooling and physical training due to Nelly's heart lesion and left-handedness, the development of the twins was remarkably similar. They had the same childhood diseases, began to menstruate together at the age of 13, and developed acne together at the age of 16. They made a fairly adequate adjustment to their miserable home conditions, were active socially and showed many outside interests. Throughout childhood and adolescence they were so close to each other that they never sepa-

rated for more than a few hours. Shortly after graduation from high school, however, Mary rebelled against her mother's domination and went to live with an older sister, while Nelly continued to live at home.

A few weeks later, in May 1938, Nelly showed the first symptoms of mental illness. For a period of ten days, she was agitated and confused, refused to speak, and thought that an older sister was influencing Mary against her. During the following fifteen months, she had several similar psychotic episodes with confusion, hyperactivity and the tendency to contact strange persons on the street. Although still virginal, she maintained a delusional idea of pregnancy. In October 1939, together with a severe exacerbation of her acne, she became so negativistic and disturbed that she required admission to a mental hospital* where she was diagnosed as a catatonic form of schizophrenia. Following insulin shock therapy, she showed marked improvement of both her mental condition and her acne and gained over 30 lbs. in weight, now surpassing Mary by about 20 lbs. At the time of her parole in April 1940, she was still moderately defective in her emotional reactions and unable to get along with her mother, but she had no difficulty in supporting herself as a waitress. She took up housekeeping in a rooming house with her twin sister and led a fairly active social life, having dates and going to dances.

During this entire period, Mary worked steadily and disclosed no evidence of emotional imbalance. She continued to behave in a pleasant and capable manner until she began to show certain personality changes in the spring of 1942. She became tense and restless, felt discriminated against at the factory and expressed similar delusions of pregnancy as her twin sister. At the same time she developed a very severe and extensive acne. Upon hospitalization in December 1942, she presented a rather insidious type of schizophrenic symptomatology with general intellectual dulling, mild confusion and vague somatic delusions. She complained that an unpleasant odor was emanating from her body and that people stared at her on the street because they noticed a terrible transformation in her. Within a few weeks she appeared to undergo a spontaneous remission so that it was considered inadvisable to proceed with insulin shock therapy. When she was placed on convalescent status in March 1943, she showed a mild personality disintegration, but no evidence of any acute psychotic symptoms.

The mental condition of both twins remained fairly stable until the end of 1943, although Nelly's moral and social standards markedly deteriorated. Following their mother's death, Mary kept house for her father and went through an unhappy love affair. Nelly refused to live at home and defied even her devoted twin sister. When she was found to have acquired a syphilitic infection, she was admitted to a general hospital for treatment. There she managed in February 1944, at the age of 24, to commit suicide by jumping out of the window although she had been placed on watch.

In response to Nelly's suicide, Mary showed increasing emotional instability and social maladjustment. She felt very guilty about Nelly's death, but denied any suicidal thoughts regarding herself. She gradually developed symptoms similar to those shown in 1942, and had to be readmitted to a mental institution in November 1945. Following insulin therapy, she was found so much improved that she could be discharged in February 1946. Since then she has been living with her father, without too noticeable signs of maladjustment.

In a comparative analysis of the his-

*We wish to express our appreciation of the excellent cooperation extended by Dr. Clarence H. Bellinger, director of Brooklyn State Hospital, and his staff in the study of this twin pair. It may also be stated that a part of the presuicidal history of these twin sisters was reported by Drs. F. J. Kallmann and E. F. Shea at a meeting of the New York Society for Clinical Psychiatry held on February 11, 1943.

tories of these monozygotic twin sisters, several specific differences are as readily apparent as are their general similarities in the adversity of home and family background, psychosexual maladjustment, acne vulgaris, schizophrenic type of psychosis, and a relatively favorable response to the treatment of both acne and schizophrenia. The main differences were entirely in disfavor of the twin who ended by suicide. In chronological order, they consisted of (1) a congenital heart lesion which interfered with the development of a stronger type of physical constitution in Nelly and, most probably, created in her a feeling of inferiority to her healthier twin sister; (2) an earlier onset and more severe form of schizophrenia, which resulted in a more pronounced personality disintegration following the institution of shock therapy; and (3) a more deleterious impairment of judgment and morals, which brought about a complete separation from the family, a tendency to promiscuity and, finally, the acquisition of syphilis.

The cumulative interaction of all of these factors apparently led Nelly to assume that suicide was the only logical conclusion. It seems unlikely that heart defect and syphilis would have had the same detrimental result without a background of family deprivation and schizophrenic psychosis. It is beyond question, however, that this disastrous culmination was related to the twin who had been at a disadvantage from birth, although it is equally certain that there are many more seriously handicapped persons who do not commit suicide.

The most important *general conclusion* to be drawn from these twin observations is that except for rare suicide pacts, self-destruction does not seem to occur in both members of twin pairs, even if the twins are alike in type of personality, cultural setting, social frustration, and depressive features of a psychosis. It is highly improbable that concordance of twin partners as to suicide has not been regarded as sufficiently interesting to warrant publication. There are so many other concordant twin observations on record, including accidental death at different times, that it is most unlikely, if twin partners should ever have both committed suicide, that so conspicuous an event would have gone unrecorded.

Reasons for Discordance

If one disregards this very remote possibility, there remain only two possible explanations for the rather remarkable finding of apparently consistent discordance of twin pairs as to suicide One explanation would be that persistence and ambivalent intensification of *sibling rivalry* in adult life may constitute a very powerful motive for the tendency to self-destruction in one member of sibship pairs who find themselves in an especially competitive situation. Corroboration of this theory requires statistical evidence to the effect that "only children" have a significantly lower suicide rate than is found in those persons of the same age group who had at least one sibling while they were alive. Unfortunately, we were unable to discover any adequate information that would prove or disprove such a contention, and we therefore started an investigation of a representative sample of suicides in collaboration with the Division of Vital Statistics of the New York State Department of Health. The study involves various statistical difficulties and has not been completed. So far we have not succeeded in verifying more than a few isolated instances of suicide in persons who had definitely no siblings.

The other explanation for our twin observations is that suicide seems to be the result of such a *complex combination* of motivational factors as to render a duplication of this unusual constellation very unlikely even in identical twin partners who show the same type of psychosis and a very similar degree of social privation. Unless further investigations disclose that there are very few suicides in only children, we are inclined to favor the second explanation. In this case it would generally be justifiable to classify the psychopathology of

suicide as an *abnormal twilight state of self-destructive ecstasy* in response to the inability to adjust to some particular intertanglement of competitive life circumstances.

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THE DECLINE IN INTELLIGENCE

Much depends on the answer to the question how much of the scatter of intelligence in our population is due to inheritance, and how much to differences in schooling and education. About this there has long raged acute controversy, which has recently flared up again in America, after a period during which it was generally agreed that from 50 to 80 per cent of the scatter was due to heredity. That fairly quiescent period followed the appearance of the *27th Yearbook of the (American) National Society for the Study of Education,* which was devoted to this problem and contained papers which, while conflicting, did so on the whole only within the above limits.

In 1940 however there appeared the 39th Yearbook of that society, among the articles in which there is much greater disagreement, bteween (one might say) a Californian school headed by Lewis Terman and the late Barbara Burks, claiming a very large influence for heredity, and an Iowa school, headed by George Stoddard and Beth Wellman, denying this and making big claims for schooling. Among the kinds of research which are used in attempts to distinguish between nature and nurture are correlations between intelligence scores of identical twins, between foster children and foster parents, foster children and true parents, children brought up in a homogeneous environment like an institution, and so on. The Iowa school base their conclusions mainly on large increases in I.Q. following nursery school and infant school education, which are not confirmed by other investigators, and are criticized as being either due to the inaccuracy and overhigh standard of baby tests, or to selection and statistical errors in the treatment of the resulting data.

Of the 2 or 3 points of decline of I.Q. per generation which the differential birth-rate data indicate, we are therefore unable to say with confidence how much is due to heredity and how much to environment. When, in a memorandum to the Royal Commission, I said that I feared the decline was one point, I meant one point due to heredity and to selection. It may well be more, but I hardly think it can be less. Particularly emphatic seems to me the fact that while the correlation between the intelligence test scores of siblings is about ·5, that between all twins is about ·7, and between twins after removal of all pairs where sex, bloodgroup, or other criterion indicates a double conception, this correlation rises to about ·9. This last rise in particular seems inexplicable except by a genetic explanation, and suggests that a considerable part of what we call intelligence is inherited. Its genetic background is probably complex and in all probability a large number of genes are concerned.

* * *

However that may be, and whether the decline calculated from the differential birth rate be genetic or environmental, it is in either case a serious matter for the nation. If the lower

intelligence of the members of large families is an educational result due to the overcrowding and poverty of the home, it could, with goodwill and suitable legislation, perhaps be cured in half a century. If it is genetic and inherited, a longer time will be needed to restore the loss, if indeed it can be restored, for although social conditions may alter so as to equalize the birth rate over the range of intelligence, it would be necessary to do more than this, it would be necessary to create a differential birth rate in the opposite direction, in order to restore what has been lost.

Need for a Direct Experiment

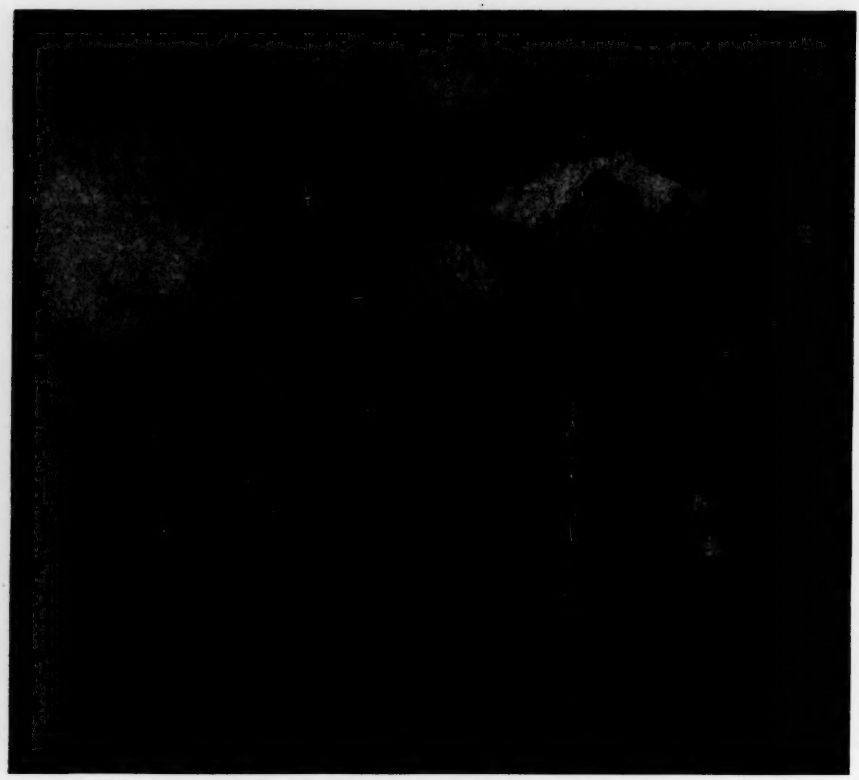
It is comparatively easy to obtain support for the kind of reform needed to equalize the cultural and educational handicaps of large versus small families. Some of these reforms might also assist in equalizing the birth rate, though others, however desirable for other reasons, might even accentuate it. It is much more difficult to obtain support for reforms tending to eugenic progress, partly because the man in the street thinks them impracticable, but largely because he does not believe in the alleged decline in intelligence. He is very sceptical about conclusions concerning the difference of intelligence between two generations when these conclusions are based entirely on measurements made on only one generation. He demands a straightforward measurement of two succeeding generations, and I sympathize. *Actual measurement of two successive generations is desirable, indeed essential, and I would urge all who are in a position to facilitate such an experiment, or to contribute towards carrying it out, to do so.*

Even when measurements on two successive generations are made however, there are still difficulties in the way of interpretation. The testees will probably be school children of about the age of eleven, because that age, before children have scattered into different kinds of scondary school, is the time when a large random sample can most readily be obtained. The sampling would have to be equally complete in both generations, if the pedant will allow me to qualify the word "complete." If, for example, defectives in special schools were included in the one case but excluded in the other that would queer the comparison. Then there is the effect of migration. There may have been an influx of children of a new type or a different race or social class into the district or country. Further, the children of the later generation may have become accustomed to intelligence tests, and be thus enabled by familiarity with the situation to score higher marks than their fathers did when children. These and others are real difficulties. They should not however deter us from making the experiment with such precautions as we can devise. The question awaiting a decisive answer is of such importance that it would be worth while to go to much trouble, and to spend money freely, in order to settle it. I hope that this may be done in our time.

A Possible Compensation

If it be true that there is going on a steady fall, generation by generation, in that intelligence which we measure or estimate by our present-day intelligence tests, may there not perhaps be compensation, it may be asked, in an increase in some other form of intelligence which may be more suited to the needs of the future. For example, is it possible that although verbal intelligence is decreasing, mechanical intelligence is increasing? There is against this hope the fact that nearly all if not all correlations between mental tests are positive. This seems to make the hypothesis improbable, but it does not make it impossible, for it is conceivable that this fact too is changing, and that the selection which is going on generation by generation, owing to the differential birth rate, may land mankind in an epoch when what we now call intelligence is actually correlated negatively with what will then be called intelligence.

I do not myself share this view. I think that intelligence is much more one thing than such a view would suggest. It is true that in the adult it takes different forms, due mainly in my opinion to his education and the influence of the environment in which he passed his formative years, though possibly also due to inherited powers which mature only in adult life. But although intelligence expresses itself in different forms, in its highest aspects it is always concerned with abstractions and concepts and relationships. Practical intelligence, as it is called, is of considerable importance in the world: but theoretical intelligence is of immeasurably greater importance. The clever garage mechanic may improve a motor-car engine. The student of thermodynamics or of atomic physics is much more likely to make the motor-car engine obsolete and replace it by a more efficient engine. And such men think in abstractions, often clothed no doubt in symbols of some sort or another, symbols which may be verbal, or mathematical, or, like Faraday's tubes of force, more mundane and materialistic, but symbols nevertheless, the real values with which these minds are operating being abstract relationships. I think there is a power of thinking abstractly which we can recognize in some of our fellow men whether they be chemists or classics, artists or mathematicians, craftsmen or administrators; and that though these men of high intelligence (as I shall call them) may, whether from education or heredity, possess different factors of the mind, they are alike in operating with them at a high level. This level is what I call intelligence, and it is, I fear, being steadily lost to Europeans by the selecting power of the differential birth rate, those who possess it tending to have fewer children than those who don't. — Dr. Godfrey Thomson, *Eugenics Review*, April, 1946.



ALMOST IDENTICAL TWINS

THIS Siamese twin lamb is a black sheep indeed. Her age is in doubt (extremely young, certainly), and it is known that she never drank nor gambolled. But there is no doubt about her lethal record: matricide, fratricide and suicide — all before she was born. But no blame attaches to her for this: like Oedipus Rex, she and her fate were conceived simultaneously.

The known facts are unfortunately scanty. In the spring of 1944, an Indiana farmer found one of his ewes, dead. Inside the ewe he found these female Siamese twins and a normal male lamb, also dead. Reverend John W. Baechle of St. Joseph's College, Collegeville, Indiana, where the mounted Siamese is on exhibit, provided the photograph and the following data:

The lamb had one esophagus, but two tracheae. The extra trachea was dorsal to the esophagus with its epiglottis pointing in the opposite direction from the other trachea. There was one diaphragm, but two hearts, one somewhat smaller than the other. There were two sterna, one dorsal, one ventral, and both common to the two halves of the animal. The left ribs of the right lamb and the right ribs of the left lamb were attached to the dorsal sternum, while the opposite ribs were attached to the ventral sternum. The number of stomachs was undetermined. Duplication in the head had progressed no further than an extra pair of ears, placed on the back of the head. Six of the legs were in a walking position, while the twins' respective right and left forelegs extended, symbolically, perhaps, like horns.

A RECURRENT MUTATION OF DOMINANT ACHONDROPLASIA IN CATTLE*

S. W. MEAD, P. W. GREGORY, AND W. M. REGAN

IN the spring of 1944 Mr. Ted Warren, then Western Field Representative of the American Jersey Cattle Club, and Mr. Enoch Torpen, farm advisor of Sonoma County, California, informed the writers independently of a Jersey herd in that county consisting largely of dwarf cows. Both men had seen the herd, and each believed the small size to have been conditioned by heredity. Mr. Torpen volunteered to assist in a gentic analysis.

The authors first visited the herd in the late summer of 1944. The owner, Mr. Glen Laughlin, has an excellently managed dairy herd of about seventy milking cows, mostly high-grade Jerseys, including a small number that are registered. There are a few Holsteins, Holstein-Jersey hybrids, or animals resulting from the hybrids backcrossed to Jersey sires. He provides abundant green pasture the year around, feeds according to production, belongs to a cow-testing association, and in general keeps abreast of the newer developments in dairying. On twice-a-day milking, his herd has maintained a cow-testing-association average of slightly over 500 pounds of butterfat for the past six years, which is very high production.

During the first visit the producing cows were inspected in the pasture. Some were obviously of normal size, whereas others were small. It appeared that they formed two discontinuous classes. The owner realized that his herd was unique. His curiosity was aroused, and his cooperation was enlisted to obtain the body measuremnets of each individual in the herd.

In November, 1944, Mead and Gregory collected the data. All the preliminary work was done in Mr. Torpen's office. From the herd and the cow-testing books, all animals in the herd were listed by sire in numerical order, and also by name. From these "sire sheets" a complete list was made, with space provided for recording the body measurements and classification of each animal.

When the work began, all cows in the milking herd were in stanchions eating hay. None of the cows were excited or unduly disturbed and accurate measurements were possible. The owner identified each animal. Mead and Gregory took the measurements, and Torpen recorded. As each animal was measured, it was classified as normal or mutant. All four workers made an independent classification. With only three exceptions, which will be discussed later, there was complete agreement on each classification. The whole heard stood quietly while being measured and classified, which took less than three hours.

Body Measurements

The body measurements taken were height at withers, length of body, depth of chest, and heart girth. Height and heart girth are the standard measurements most commonly used. The body length is the horizontal distance from the anterior tip of the shoulder point to the intersection with a perpendicular line passing through the posterior point to the pin bones. Depth of chest was determined with callipers placed posterior to the forelegs. By subtracting the depth of the chest from the height of the withers, one could obtain the so-called "leg length."

The cows measured were from two to ten years old, but the majority were under five. Table I contains the body measurements of all cows four years old or over. When the younger animals were broken down into different age classes, the numbers in each class were so small that no attempt was made to

*This work was supported by the Kellogg Fund of the University of California for the application of genetics to farm animals.

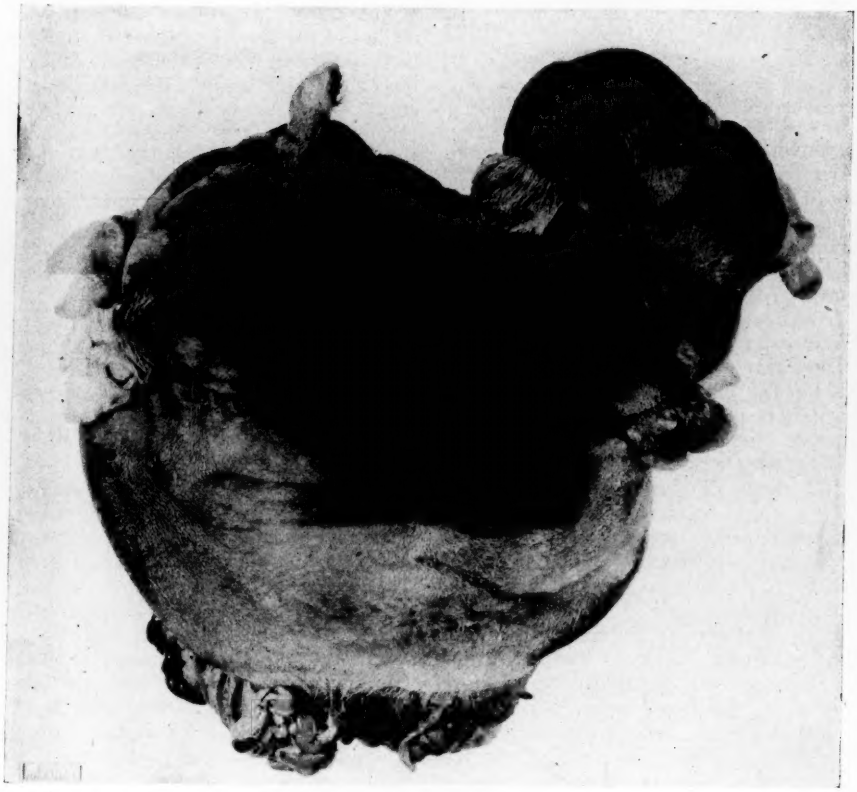
NORMAL MOTHER AND DWARF DAUGHTER
Figure 6

The cow at the right is normal; and the one at the left is her mutant daughter, four years of age, sired by Oxford. Note the difference in height and in length of legs.

analyze the data, although these cows were used in the analysis of genetic ratios.

As Table I reveals, all cows classified as mutants were consistently smaller than the normal cows of the herd. In height at withers and in leg length there was complete discontinuity between normals and mutants, and only a slight overlapping in body length. The differences in these measurements between the two classes are statistically significant. There is considerable overlapping in depth of chest and heart girth. It is obvious that mutant animals measure slightly smaller in those dimensions but a relatively large sample would be necessary to show significant differences between the two groups. Obviously the mutant gene affects the development of both the limbs and spinal elements of the skeleton, but the limbs are more drastically reduced.

Since there is no overlapping between the normal and mutant types in height, there was little or no difficulty in classifying the individuals. As was mentioned earlier, there were three animals regarding whose classification the four of us disagreed in the first "ballot." Two of these were mutant, but they were Holstein hybrids and were therefore much taller than the mutants of pure Jersey breeding. The third one that caused confusion was a normal Jersey heifer about 2½ years old; she had calved early, was a heavy milker, and consequently was small for her age. Upon close examination all agreed that she was of normal phenotype. Thus no mature animals remained "unclassified," nor were any in-



HOMOZYGOUS DWARF
Figure 7

Photograph of a homozygous achondroplasic calf born November 29, 1944, from heterozygous dwarf parents. Dam No. 300 (Beauty 6); sire Oxford. This achondroplasia gene resembles the Dexter-Kerry dwarf gene in being lethal when homozygous. Crosses between the two types have not been made to establish whether they are the same.

termediate in height at withers or in leg length.

Since there were no scales on the farm, body weights could not well be obtained. The measurements show, however, that mutant cows weigh less than normal sibs.

Appearance of the Heterozygous Mutants

From the foregoing discussion it appears correct to assume that in the mature cows, at least, height is a reliable diagnostic character to differentiate the two types. (See Figure 6.) Little attention was devoted to animals that had never freshened. Calves from a few weeks to about ten months of age were observed, and mutants among them could readily be identified by height. Older calves of breeding age that had not freshened were in a distant pasture and were not studied. Mutants appear to have very short legs, and the udder, if large, is naturally close to the ground —a condition which, according to the

owner, has often resulted in injury to teats.

Inheritance

Mr. Laughlin was asked when mutants first began to appear in his herd and what their origin may have been. His reply was definite. The first were born about eight years before, after he began using a Jersey sire named Alta's Oxford of Alta Cresta, registration number 366491, hereafter referred to as Oxford. All the mutants could be either directly or indirectly attributed to Oxford, who, furthermore, was himself of the dwarf type. Oxford was ten years old at the time of this study. We found him to be of very short stature. His body measurements in centimeters are as follows: length 149, height 115, heart girth 182, depth of chest 69, leg length 46. Height and leg length, the two critical measurements, prove beyond question that he is a mutant type.

Since mutants began to appear in the first calf crop sired by Oxford, it seemed likely that the conditioning gene might be dominant. Table II summarizes the results of mating Oxford to all unrelated normal cows in the herd. Eight daughters, sold before the study, were never classified. Seven of them had freshened, however, and had been in the milking herd for at least part of a lactation. Although no attempt was made to have the owner classify each of these from memory, his statements convinced the authors that several normals and at least one mutant were among the seven. As Table II shows, the conditioning gene is dominant. Since most of the bull calves were killed at birth without being classified, the data on males are limited. Two normal dams are known, however, to have produced a mutant bull calf apiece when mated to Oxford. Both of these bulls were later used as sires in neighboring herds, and one was observed by Mead. Evidently, therefore, the conditioning gene is not sex-linked, but is autosomal.

A New Gene or a Recurrent Mutation?

The heterozygous condition resembled the well-known dominant achondroplasia of cattle studied by Seligman,[4] Wilson,[5] Crew,[1] and others. Interest now lay in the appearance of homozygous individauls and in the question of heterozygous matings. All daughters of Oxford, including the mutants, had been uniformly high producers; and the owner had not hesitated to make sire-daughter matings, some of which included mutant daughters. After appropriate inquiry, the owner stated that two or three achondroplastic calves (monstrosities)

TABLE I. Comparison of Body Measurements in Centimeters of Normal (*N*) and Mutant (*M*) Mature Cows Sired by Oxford

	Height at withers													
	106	109	112	115	118	121	124	127			N	M	S.E.	D/S.E.
Normal	...	...	...	.....	2	3	2	3			10	122.8 ± 3.43		
Mutant	4	5	4	.....	...	.....	.....	.....			13	109.0 ± 2.40		
												13.8 ± 4.18		3.3
	Leg length													
	41	44	47	50	53	56								
Normal	...	...	...	1	4	5					10	54.2 ± 2.04		
Mutant	3	7	3	....	....	....					13	44.0 ± 2.08		
												10.2 ± 2.51		3.5
	Body length													
	127	130	133	136	139	142	145	148	151	154				
Normal	.....	...	.....	.....	1	2	0	1	5	1	10	148.0 ± 4.97		
Mutant	3	3	2	2	2	1	.....	.....	.....	.....	13	133.0 ± 4.95		
												15.0 ± 7.19		2.1
	Depth of chest													
	62	65	68	71										
Normal	...	1	5	4							10	68 9 ± 1.97		
Mutant	3	7	3	....							13	65.0 ± 2.08		
												3.9 ± 2.86		1.4
	Heart girth													
	157	160	163	166	169	172	175	178	181	184				
Normal	...	...	1	1	1	1	1	2	2	1	10	174.7 ± 6.81		
Mutant	1	3	4	2	1	0	0	2	.....	.....	13	165.1 ± 6.40		
												9.6 ± 9.34		1.0

had been born when heterozygous animals were mated together. He had not, however, associated them in any way with the heterozygous condition of the parents. His herd book revealed that heterozygous cows 17 and 308 had produced badly deformed calves when bred to Oxford. The description suggested that the mutant might be identical with the known dominant achondroplasia. It was hoped that this question might soon be answered more definitely, since a few heterozygous cows were then pregnant by Oxford. On November 29, 1944, the farm advisor, Mr. Torpen, telephoned the authors that an achondroplastic calf which would serve as a type specimen for study had been dropped a few hours before in the Laughlin herd. The calf, which was in a good state of preservation, is shown in Figure 7. A description taken from the protocol is as follows:

Achondroplastic female calf born in Glen Laughlin's herd, near Santa Rosa 11-29.44. Sire, Oxford; dam, a heterozygous cow #300 (also known as Beauty 6). Born 4 to 6 weeks before time. Specimen completely haired and hoofed. Weight 13 pounds.

Marked achondroplasia; all skeletal parts affected. Head asymmetrical, most likely because of a hydrocephalous condition. Palate not cleft. Mouth could not close. Opening from edge of mucous membrane of lower lip to edge of mucous membrane of upper lip at center of nares 1⅞ inches in diameter. Tongue normal in size, protruding 3½ inches through the oral orifice.

Because of curvature of the spine, the buttocks appeared to protrude posteriorly and dorsally, thus causing the anus to be lifted and slightly dorsal. Very pendulous abdomen from anosarca. Intestines exposed. Fluid had probably discharged through the umbilical vessels. No possible check on amniotic fluid in the specimen.

Dimensions in inches: Length of head from point of chin to crown of occipital bone, 6. Length from chin to anus (dorsal), 9¾. Length of tail, 2¾; width of head, 4¼; length of foreleg to end of hoof, 2¾. Length of hind leg to end of hoof, 2½. Length of ear, 2.

Teeth: 1 lower incisor erupted; 3 more not erupted, but readily felt.

Autopsy: Skin seemed thick and firm. Edema of almost all subcutaneous tissue. Pieces of lung sank in water, a fact indicating that the lungs had never functioned. The elements of the scapula, humerus, and radius were represented, but greatly shortened and distorted. Thyroid weight (wet) 7.3 grams. Brain in apposition to cranial cavity; mild hydrocephaly. Skull gives impression of being foreshortened; very little fluid in ventricles, and none between brain and skull. Vagina normal. Specimen assumed to be of the Dexter type of homozygous dominant achondroplasia. Even though the conclusive mating tests were not made, the general appearance and description of the heterzygous and homozygous mutants coincide closely with the Dominant Dexter Achondroplasia, and the two are concluded to be identical.

TABLE II. Daughters Resulting from Mating Oxford to Unrelated Normal Cows

	Normal	Mutant	Unclassified*
Observed	22	30	8
Calculated	26	26	

$\chi^2 = 1.23$
$P = .30$

*See text for more details regarding the unclassified animals.

Origin of the Mutant

All the achondroplastic animals in the Laughlin herd are descendants of Oxford. Did Oxford descend from an achondroplastic line, or was he the product of a direct mutation? Mr. Laughlin, who purchased him as a calf from a neighboring herd, was certain that both his sire and dam were of normal height; he remembered them well. This observation was confirmed by a neighbor and others who had seen them often. Thus there is conclusive evidence that Oxford's achondroplasia resulted from a direct mutation, although it cannot be determined whether the mutant gamete came from the sire or from the dam. The mutation rate of dominant achondroplasia is evidently low. Downs[2] reported a "Dexter Monster" born to a Holstein-Jersey hybrid cow and sired by a Holstein bull. Apparently the dam and sire were normal, though this point is not clear. The cow was known to have produced another "Dexter Monster" earlier, but the sire was not definitely known. As Downs recognized, while his specimen had many characteristics in common with the dominant achondroplasia studied by the earlier investigators cited, some characteristics did not agree. Had he known of the recessive achondroplasia studied by Mohr,[3] Downs might have concluded that his "monster" more nearly coincided with

the recessive type. Since the picture furnished by him certainly resembles more closely the specimens studied by Mohr, the authors believe that Downs's specimen is that of a recessive type.

This report would be incomplete without an expression of indebtedness. Mr. Ted Warren brought the mutants to our notice. Mr. Enoch Torpen, Assistant Farm Advisor of Sonoma County, also called attention to them and gave valuable help in classifying and measuring the animals. He also provided some of the records from the cow-testing-association book. Although Mr. Glen Laughlin, the owner, was faced with a labor shortage, he generously gave all the time necessary to identify, measure, and classify the animals and placed all his herd records at our disposal.

Summary

A dominant mutation that reduces skeletal development was found in cattle. Heterozygous animals may be recognized by lack of height, occasioned largely by short legs. Mature heterozygous animals are compared, as to body measurements, with normal sibs of the same age. In the homozygous state there is marked achondroplasia, which is lethal. There were no mating tests; but the condition coincides so closely with the Dominant achondroplasia of the Dexter lethal that the two are assumed to be identical. The mutation occurred spontaneously in one bull whose parents were normal in size.

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Army Wants Dogs for K-9 Corps

THE United States Army wants to buy dogs for the K-9 Corps. To assist it in obtaining dogs of suitable type and character, the Army Dog Association, composed of persons active in dog raising has been formed and is arranging for a canine assembly to which those with dogs meeting the desired specifications can bring them for possible purchase by representatives of the Quartermaster Corps, the War Department announced recently.

The following specifications have been drafted. The dogs must be pure-bred German shepherd males, between the ages of one and three-and-one-half years. They must be well boned, of good type, with erect ears and properly carried tails, sound in mind and body and free from disease. They must stand between 24 and 26 inches in height at the shoulder and weigh from 70 to 90 pounds. Any color will be acceptable except solid white or coats containing conspicuous white markings. For Army use, dogs must be steady and fearless in disposition. Shy, nervous or timid dogs will not be accepted.

Persons who feel that they have dogs meeting these specifications and who would be willing to part with them are urged to notify Raymond C. Smith, Box 331, Demarest, New Jersey. As soon as the details of the proposed sales rally have been completed, they will be notified when and where to take their dogs to have them examined by representatives of the Army Dog Association. The price paid for dogs which the Army feels meets its needs will not exceed $150.

In addition to assisting in the procurement of dogs immediately needed by the K-9 Corps, the Army Dog Association will supervise a breeding program by which a steady flow of dogs of desirable type will be assured. Because the Army does not accept dogs for training until they are at least a year old, it will be some time, however, before this part of the program will be able to meet the Army's needs.

THE INHERITANCE OF FLEXED FINGERS

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WHILE a number of abnormalities of the hands have been reported in this JOURNAL and elsewhere, streblomicrodactyly and camptodactyly have been reported but infrequently. These two terms seem to be synonomous.

Hefner[1] has reported the condition to be a result of a shortening of the tendon of the flexor digitorum sublimis muscle, which controls the movement of the finger. The finger affected is the little finger, though others may occasionally show the defect too. The condition being one of permanent flexion to varying degrees, the individual affected cannot straighten the finger, but, rather, it remains in a state resembling an inverted "V." Doubt was at first cast on the explanation given above, but Stoddard[3] has reported that massaging seems to ameliorate the condition if applied at an early age, thus supporting the theory that a shortened flexor tendon is responsible. X-rays, as can be seen from those accompanying this paper, reveal no extensive bone abnormalities. In post-natal development such environmental influences as occupation and exercise may play some rôle in the expression of the condition.

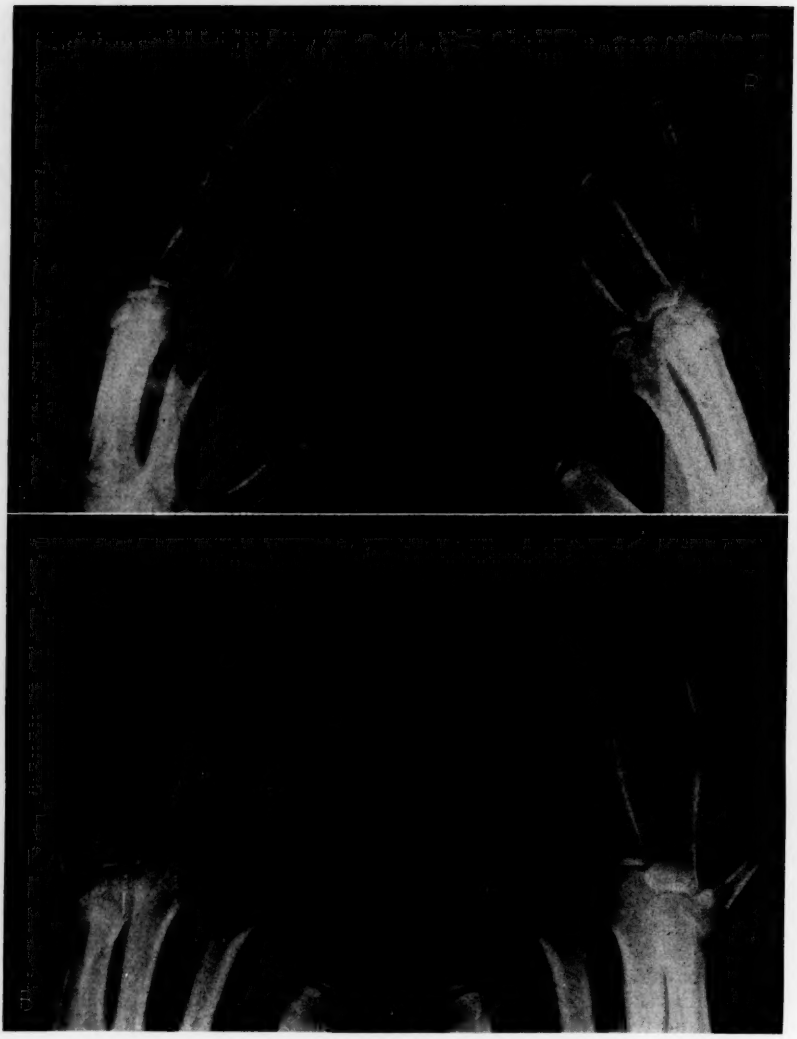
This condition, which will be referred to as camptodactyly, has been observed by the author in his own family, where eight individuals, including members of both sexes, and in five different generations are known to have been affected.

The author, V-9, in the accompanying pedigree (Figure 9) is unaffected as are brother, V-7, and sister, V-4 (now deceased). Two affected brothers, V-5 and V-8, inherit the condition from their mother, IV-7, who is also affected. She inherits the trait directly from her affected ancestors in the three preceding generations, as shown in the pedigree chart (Figure 9).

It would appear at first glance that a simple Mendelian dominant gene is involved. But closer examination of the affected individuals reveals that individuals I-1, II-1 and III-2 were all affected in four fingers per hand, whereas all other individuals showing the defect, manifest it in the little finger only. The author has had the opportunity to observe only III-2 of the three affected individuals in the first three generations of this pedigree. Perhaps the most striking feature of his hands is a lack of complete bilateral symmetry. His hands, like those of his mother and grandmother, show the defect in all fingers, with the index fingers but slightly affected. But the left hand is less severely affected than the right. A similar phenomenon is observed in individuals V-5 and IV-7, as a glance at the X-ray (Figure 8), will prove. And this is true despite the fact that only one finger is affected. Furthermore individuals IV-5 and V-2, show the defect only in the little finger of the left hand.

It would seem reasonable to assume, on the basis of the information presented herein, that a system of modifiers is involved in the inheritance of camptodactylism. One dominant gene, *A*, for example, might be necessary for the expression of the character in any form, while modifiers, say *B*, *C*, and *D*, likewise dominant, might cause the abnormality to appear in all fingers. Assuming that the gene effect is quantitative, and that no gene has an effect on any specific finger, but rather that a single modifier, when occuring with the key gene (*A*), causes the defect in the little finger only, we seem to have a reasonable theory. It is a matter of pure conjecture how an individual homozygous for dominant *A* would be affected, inasmuch as none has been observed.

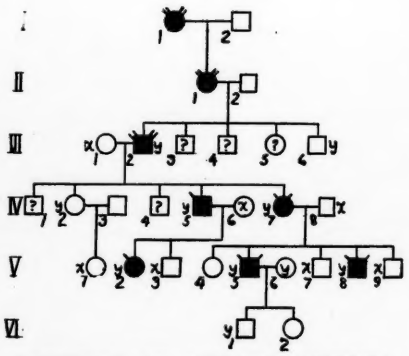
The defect is present at birth. It



VARIABLE EXPRESSION OF CAMPTODACTYLISM

Figure 8

A—This X-ray photograph of the hands of IV-7 shows the expression of the defect in its most clear-cut form in those individuals who are affected in but one finger on each hand. *B*—This individual, V-5 in the pedigree, shows the defect in his left-hand considerably less than in the right. Of all the affected individuals, he has the lightest hair.



PEDIGREE OF CAMPTODACTYLISM
Figure 9

In this pedigree the defect is less severe, the later the generation. The close association of black hair color and camptodactylism here, and in another similar pedigree mentioned by the author, suggests linkage, but data are not extensive enough to prove the point. The following symbols are used in the chart: *II* = all fingers affected on right hand; *I* = little finger affected on right hand; the corresponding symbols for the left hand are slanted to the left; *y* = dark hair; *x* = light hair.

shows no abnormal consequences other than the fact that the finger cannot be straightened to its fullest degree, nor can the affected individual stretch the finger to any degree, as, for example, in attempting to stretch an octave on the piano. Mentally, there are no ill effects, and physically, other than the defect itself, there seem to be no related phenomena. Longevity does not seem to be affected.

There is, however, one phenomenon to which attention should be called. There seems to be, in the few cases observed by this author, a definite association of camptodactylism with hair color. A glance at the accompanying pedigree reveals that all affected individuals have dark hair. There are difficulties involved in tracing this possible linkage, because the classification of hair color is influenced by personal opinion. What may be light hair at the age of fifteen, may be dark ten years later, and what one person would call dark hair another might call light. Hair color, however, has been divided into the two groups so often used by geneticist, light brown and blond on the one hand, and brunette and black on the other.

On the basis of the two groups, the reader will see that there are no affected individuals with light hair (represented by *x* in the accompanying pedigree), but that there are six affected individuals with dark hair color (dark hair color being represented by *y*). In addition, there are three unaffected individuals with dark hair, and four unaffected members of the family with light brown or blond hair (in counting individuals and their hair color, only sibs have been counted). Linkage, while strongly suggested, is by no means certain. Doubt is cast on the theory by the fairly involved nature of the transmission of hair color itself, but we must not overlook the possibility of linkage. Furthermore, the author has observed a finger abnormality similar to this one in another family, and there too, as far as can be determined a similar relationship exists.

Perhaps the most unusual feature of all the facts concerned with possible linkage of camptodactylism and hair color is that, of all the camptodactylous cases observed in the author's immediate family, the person least affected, individual V-5 has the lightest hair, his hair being dark brown, while all other affected individuals have very black hair. A glance at his X-ray (Figure 8) will show how slightly his little finger is flexed whereas others have fingers in a state of far greater flexion, and how different are his right and left little fingers. Individual IV-5, however, and his daughter, V-2, have the abnormality in their left little finger only, and yet have the very blackest hair.

Hefner[2] has reported that the x-rays of a similar condition revealed the curved termination of the proximal phalanx of the affected finger. A similar condition can be noticed to a slight degree in those affected in the family studied here. Figure 8*A* shows that feature best. In the same report, Hefner has also re-

ported that dolichodactyly (long, slender fingers) seemed to accompany the condition. In the cases observed by this author, the hands are of normal size, and the fingers, likewise, are normal as to length and breadth.

Where the flexion is less, Heiner[2] has applied the term of minor streblomicrodactyly, but where he draws the line is uncertain. There is little doubt that, basically, we are reporting a similar condition, and until the terms camptodactyly and minor streblomicrodactyly are more clearly defined the author suggests that they be considered synonomous.

Summary

1. The inheritance of flexed fingers, which is known as camptodactyly or streblomicrodactyly, seems to be due to a single dominant with the phenotypic expression influenced by genetic and environmental modifiers.

2. There is evidence that the character is linked with hair color but the data are not extensive enough to prove the point.

Literature Cited

1. Hefner, R. A. *Journal of Heredity.* 15:481. 1924.

2. ———— *Journal of Heredity.* 32: 37-38. 1941.

3. Stoddard, Edmond S., *Journal of Heredity* 30:510-512. 1939.

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A DEFINITIVE CHROMOSOME ATLAS

SINCE the appearance of Marchal's and Tischler's lists of chromosome numbers in the early 1920's every worker in the field of genetics, cytogenetics, plant breeding, cytology and related fields has looked forward to any method by which the vast literature could be more easily checked. As the particular interest changed, or as he mentally planned new work he consulted the lists by Gaiser, Kihara, Sugiura, Maude or more recently Bowden. It can be truthfully said that this new book* will receive a great deal of consideration from this standpoint alone since it is as extensive and as up to date as it is possible to make such lists. It will be very valuable to the many workers whose research approaches or concerns the economic plants, and they will appreciate the completeness of the lists presented. Over 10,000 species are listed and they include the so-called wild relatives as well as the cultivated species of that group.

The lists themselves are preceded by a brief, but excellent introduction which calls attention to the larger problems confronting a worker if he is to contribute his just share. This is a hint to those who simply conduct chromosome surveys. The book is dedicated to Vavilov and his work on the "Centers of Origin" receives a prominent place in the introduction. The most commonly accepted explanations which account for polyploidy are pointed out and the vast influence which domestication, with its resultant selection, has played in this evolution is all too briefly presented.

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* Darlington, C. D. and E. K. Janaki Ammai: Chromosome Atlas of Cultivated Plants. Pp. 397. George Allen and Unwin Ltd. London 1945.

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